IX. XVISION: COMMISSIONING

While the process required a great deal of time, the establishment of a working partnership with Bendix was a key aspect of the ADOT research project's new directions. The Bendix infrared night vision system was not yet being widely distributed in mid-2001, and the program was still exploring its potential for specialty vehicle applications.

The evaluation concept for the original XVision unit was straightforward, as worked out by the TAC, Bendix, and other ATRC partners. Bendix offered a night vision concept that was clear and intuitive; they therefore developed only limited training material and operating guidelines. Still, these materials were a necessity so that each driver would understand the abilities and limitations of the thermal imaging equipment.

The ATRC evaluation program was to utilize the standard operator shift reports from previous winters to detail the system operating conditions during plowing activity. ATRC also would work with Bendix on their specific needs, which were primarily for driver feedback on system performance. Bendix furnished an incident report form to describe any event when the system did or did not give a warning or influence the driver's decisions. The ATRC also adapted the Bendix report for the EVT-300 radar, to provide an evaluation tool that was consistent for both systems (Appendix F).

COMMISSIONING ACTIVITY

The Bendix XVision system was not quite ready for its market rollout in late 2001. Hoping to get early Arizona field results in the 2001-02 winter, Bendix offered an early-production XVision camera and HUD display to ADOT on an evaluation partnership basis. While this agreement was being worked out cooperatively, the key details at the field level were more of a challenge.

The first plan was to install the XVision camera side-by-side with the Eaton VORAD radar on the ADOT-3M snowplow F342 at Gray Mountain, to compare the two forward warning systems. However, this would have seriously overloaded both the electrical system and the plow operator. Also, this ADOT-3M snowplow was still scheduled for extensive joint training and evaluations with the Caltrans RoadView ASP in Year Four, and adding the night vision system would have complicated that side-by-side evaluation.

Another snowplow would therefore be needed to test the XVision system. The Flagstaff District in Year Four was providing basically all of the material and staff support to the research project, so it was clearly a decision for the local managers to resolve. By the fall of 2001, it was agreed to evaluate the XVision system on an ADOT snowplow stationed at Williams, west of Flagstaff.

This was a sound plan since the Williams crew patrolled both Interstate 40 and State Route 64 leading north towards the Grand Canyon. As a result, the project's 2001-02 research program workplan document listed snowplow F278 as the Bendix test plow, however, that was premature.

A variety of local issues in the fall prevented the XVision installation at Williams, in particular ADOT's procurement processes, but also a series of internal delays for Bendix. The system and the test unit were not fully ready for product delivery, and the XVision system was finally received by ADOT in the last week of January 2002. At that time, however, a decision was made

to not use Williams as the test site after all. Instead, the Flagstaff District decided to assign a plow from Little Antelope Camp on I-17 for the XVision evaluation.

The first XVision system was finally installed on snowplow F235 in February. Commissioning problems delayed the initial field tests and shortly after the installation, this vehicle was taken off line for other scheduled snowplowing equipment upgrades to be performed at the Phoenix shops. There would be no more opportunities to field test the XVision system, as this mild winter was ending, and the snowplow was out of service until April.

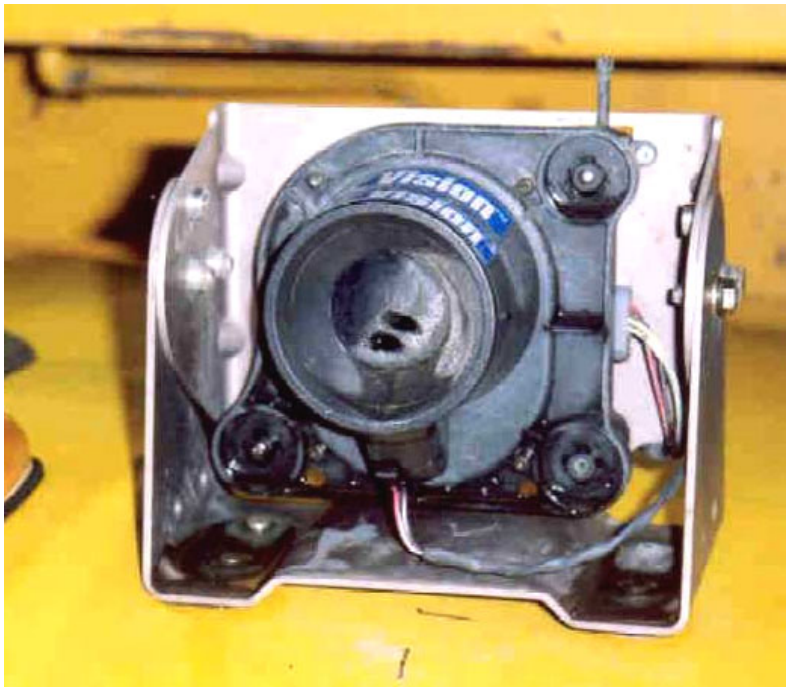

Figure 19. Basic XVision Mounting Exposed to Spray and Debris

When the truck was returned to Little Antelope, one longstanding issue remained for the XVision system. The two operators were initially enthusiastic about the system, but they found vibration to be a real issue for the system's HUD (Figure 16), which was mounted overhead. During the initial night familiarization runs, the Mack snowplow truck produced continuous vibrations in the two-mirror HUD projection system. The vibration problem prevented target identification during several storm patrols in spring rains and in low-lying fog along the I-17 corridor.

At this time, the only option that Bendix could offer was new mounting hardware. The HUD mirrors did not vibrate so badly on the softly sprung long-haul tractor-trailer rigs that were the primary market for XVision. In May, ATRC and Bendix took steps to identify an off-the-shelf LCD screen to be substituted for the tremor-prone mirrors of the head-up display unit. The XVision HUD unit did have output jacks for a secondary passenger-side screen, which had been provided for observation during the HUD development phase of the Bendix design program.

Locating a suitable LCD display screen was not a major problem, and it was obtained by ATRC from a Phoenix-area electronics supply house. Unfortunately the selected unit was imported from

a developing nation, and its rudimentary wiring diagram forced a second screen purchase before the upgrade was finally successful (Figure 20). Later, a Bendix unit would be substituted.

May 2002 Stakeholders Preview

One key aspect of the XVision program for ADOT was to rekindle some of the enthusiasm in the districts and among the TAC members for the snowplow research effort. With the conclusion of the Caltrans partnership, the project was no longer focused on an intensive side-by-side guidance system evaluation program.

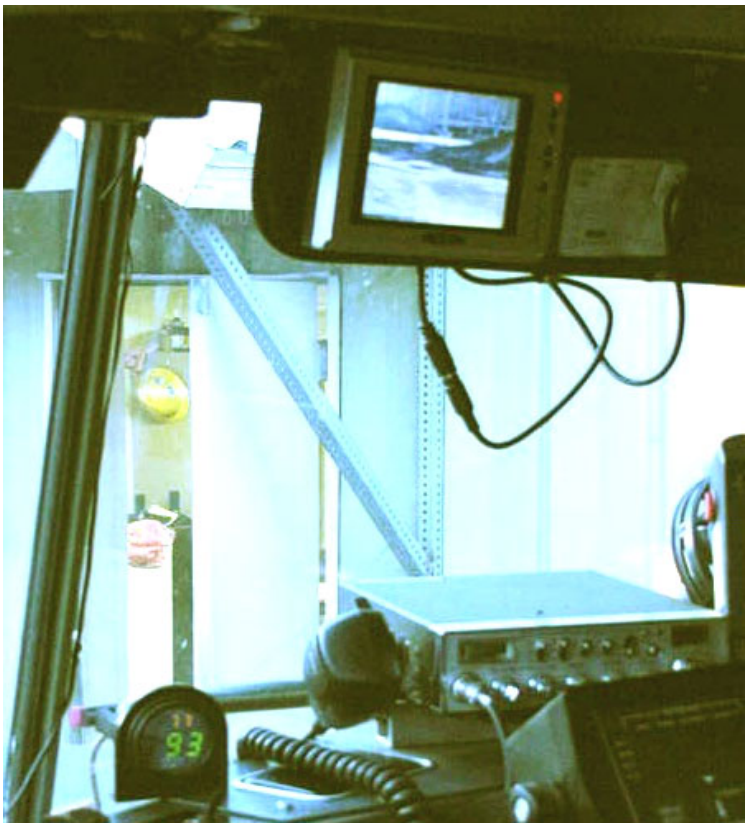

Figure 20. Visor-Mounted LCD Screen for May 2002 Demo

While the TAC had directed a new effort with on-board systems, not all TAC members were familiar with what other concepts might justify commitments in new directions. One aspect of bringing the program back into focus was to demonstrate the candidate on-board systems to the stakeholders, and night vision was a concept of real interest for many of the TAC members.

With the new LCD screen installed at last, the ATRC scheduled an XVision demonstration at the Flagstaff District's Rim Camp yard on US 89A. This "night demo" event took place on May 29, 2002, and a total of ten ADOT plow operators, supervisors and managers from three core TAC districts were on hand, as well as several project team members and visitors from Phoenix and Northern Arizona University. Most of the visitors were able to take 10-minute test rides, and they then filled out a brief opinion survey.

The TAC survey results from the brief initial test ride were favorable, and all testers rated the system on the positive side of the scale. More helpful were the open-ended comments that expressed a strong positive reaction to the extended vision range and to the clarity of the image. There were also a few concerns voiced about image size, mounting position and lack of clarity in some images. In general, however, all of those who witnessed the XVision demonstration rated it highly and were enthusiastic about real-world testing by ADOT in the next winter.

Installation of Additional Night Vision Units

As noted earlier, ATRC polled all of the TAC members on the overall direction of the research program following the May demonstration, and as anticipated, tests of on-board warning systems became the basic Year Five goal for the project. Along with the CWS radar systems, ATRC was also directed on July 30 to procure two additional Bendix XVision systems.

With this clear direction from the TAC, the new units were purchased for deployment on ADOT snowplows at Winslow and at Kingman. This plan provided for testing of three XVision units in diverse storm and terrain conditions that range from the I-17 corridor near Flagstaff, to US 87 south of Winslow in the forested Mogollon Rim area, and to I-40 where it rapidly climbs into the rugged Aquarius Mountains east of Kingman.

Procurement of these additional units was straightforward, with ADOT Equipment Services staff helping to overcome the traditional procurement obstacles. The new XVision units would now be furnished with a standard flat-screen display, and the original unit on F235 would also be retrofitted with the latest Bendix screen. Later on, new debris shields would also be provided if conditions required. The procurement effort, initiated in August, was completed in October.

Within a few more weeks the new systems were received, and all installations were finally completed by December 3, 2002. At this point the northern region of Arizona had only seen about three inches of snowfall so far, and the entire winter season remained for XVision testing.

TRAINING & TESTS

Bendix XVision is an extremely advanced passive-infrared system. One of its key advantages is that it is fundamentally intuitive for the driver. With the original HUD concept, the displayed image is at the proper scale and angle for the driver to instantly relate it to the visible scene directly ahead. However, as ADOT transitioned to the LCD display screen, mounted at the center of the dashboard, the driver's visual and interpretive efforts were slightly increased. Still, this was just an issue of driver familiarization and level of confidence in interpreting the image.

Bendix provided basic driver handout materials with XVision, along with a set of installation and marketing videotapes to illustrate the general concept and performance of the infrared system. The vendor did not develop extensive training materials because they were not considered necessary for successful adaptation to night driving with XVision.

The ATRC utilized the various Bendix materials to introduce drivers to the XVision system, after a preview and feedback session with the project TAC members. Copies of the videos, brochures and operator's guidelines were provided to each maintenance camp with the new system, and to each district Equipment Services shop as well.

Fundamentally, this approach was successful, although ADOT drivers sometimes encountered issues in troubleshooting system performance or malfunctions. There was occasional confusion as to expectations for the startup sequence, and concern about proper switch settings. Learning to interpret the infrared display was more challenging, especially at twilight, for example with a negative image on the screen of black sky and white trees ahead.

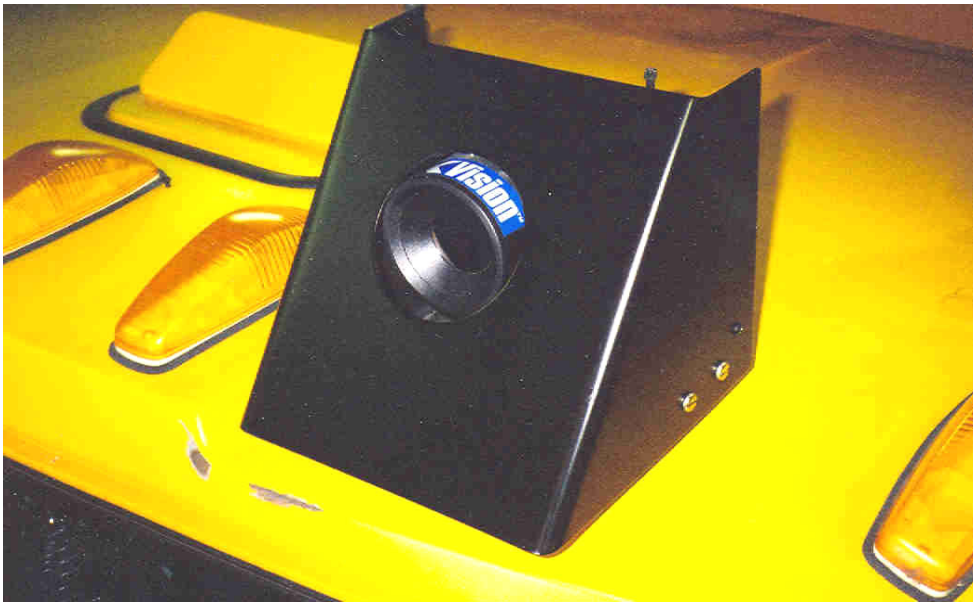

Figure 21. XVision Shield Added to ADOT Snowplow F235

The ATRC emphasized that all snowplow drivers in each participating Org should be briefed on the night vision system, in case they were assigned in mid-season to the research plow. The primary operators were also asked to make several night familiarization runs on their assigned snowplow routes before the first storm, to develop confidence with regard to interpreting the images, and to identify roadside features or conditions that might be confusing.

The drivers were generally quick to learn the idiosyncrasies of heat-based image intensity and the unique heat signatures of roadside objects such as guardrail, signs, rocks and trees. The general reaction of new drivers to the XVision's thermal imaging concept was that it was a tremendous improvement for night driving of heavy fleet vehicles, especially in hazardous environments.

The ATRC's 2002-03 winter testing plan, due to the wide dispersal of the three test snowplows, was not based on group training and evaluations. It depended instead on feedback at the local level using snowplow shift activity reports, system incident reports, and periodic driver surveys.

2002-03 INFRARED NIGHT VISION OPERATIONS

All three snowplows had been equipped with operational XVision systems by December 3, 2002. Most of the season's snowfall was yet to come, so a comprehensive and valid testing program was anticipated. ADOT's in-house PECOS data management system tracks winter maintenance activities such as plowing, chemical or abrasive applications, and winter storm patrolling.

Appendix D provides a complete summary of storm-related operations and weather observations for both radar and night vision-equipped snowplows during the 2002-03 winter, while Table 6 below shows the extent of evaluation usage for the three project plows with the Bendix XVision passive-infrared night vision technology.

Table 6. ADOT Winter Storm Activity with Bendix XVision

Project 473 Winter 2002 – 2003			
PLOW DATA	F277	F235	F340
MAINT ORG:	Kingman	Little Antelope	Winslow
Total Reports:	*12*	*72*	*40*
System:	XVision	XVision	XVision
Highway:	I - 40	I - 17	SR 87
Mileposts:	54 – 72	335-340	317-290
Installed:	3-Dec-02	7-Feb-02	3-Dec-02
Dates / Miles Summary			
Sum of Miles:	1,729	10,871	6,863
Use-Days:	6	39	22

These activity records show that during this winter evaluation activity, the project snowplows accumulated nearly 70 total days of on-the-road snowplow experience in almost 20,000 miles of highway driving. All three snowplows were fully operational by early December, and were in use for almost the entire 2002-03 winter. The Flagstaff region received all but three inches of its 55-inch snowfall total for the season after the date that all three night vision plows were in service.

The Bendix XVision units experienced some basic issues on the three test snowplows that affected the overall driver ratings for the 2002-03 winter. Expectations were very high in the fall, but as problems with snow buildup on the camera lens were observed, significant frustration and reduced levels of satisfaction developed for several of the project's snowplow operators.

As noted by Bendix initially, passive-infrared was not specifically designed for continual service in the high-moisture conditions that snowplow vehicles often experience. XVision was designed and tested as an all-weather system but was not developed specifically for severe storms. ADOT and Bendix worked continually through the Phase Three winter to develop solutions, and are still evaluating new approaches for 2003-04, including a third-party lens-washing system, to resolve the snow blockage problem for the camera lens.

More detailed information on the XVision performance, and on the ADOT operator perceptions of the system, will be found in the following sections on the 2002-03 research activities.